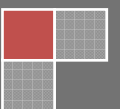


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Safe Water in Informal Settlements

Why it Matters and How to Get It

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Brian Banks
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For most Americans, a refreshing glass of water is just a few steps away. Filling a cup is as easy as turning on a tap, and Americans know that the water will be clean and safe. While it can be easy to take this luxury for granted, few people around the world can relate. According to the United Nations, "almost half of the world's population faces a scarcity of water," (The Millennium Development Goals Report 42). The amount of water the average American uses in one day could last nearly two months for the average resident of Mozambique (Fact Sheet: Use of Water 1). The global water crisis is not a matter of convenience, but of life and death. Shortages of safe water around the world contribute to more than four billion cases of diarrhea annually. Of these cases, diarrhea kills 2.2 million people, mostly children, every year (Trowbridge). Almost all of these deaths are easily preventable. The lack of water does not just affect people's health; water poverty also has tremendous economic and social impacts. These impacts are especially strong for the urban poor living in the informal settlements of the developing world. This is a sizeable population at nearly 1 billion people, and is expected to double by 2030 (The Challenge of Slums 37). These communities are disadvantaged by a lack of public services, high population density, and low levels of sanitation. These factors, as well as others, result in an acute water crisis and severe consequences for this rapidly growing segment of the world's population. This paper will look at what the importance and benefits of clean water are and how to take advantage of those benefits. In order to do so, this paper will look at the benefits water can have in development, health, and social and economic status. The paper will then look at the range of opportunities for providing access to safe water to those living in informal settlements. Based on this information, several policy recommendations will be made.

Water and Development

Since the close of WWII, efforts have been undertaken by developed nations to alleviate the suffering of those in less developed countries. Development represents the path towards greater control of individuals and communities over their destiny. Water poverty, endemic to the developing world, is detrimental to this process in many ways. Development has been looked at and defined in many ways, but in nearly every view of development, improving access to water plays a vital part.

Over the past three decades, a new trend has emerged in the way that the developed world works with developing countries. Top-down development approaches have been replaced with the paradigm of “participatory development.” Participatory, in this framework, “refers to involvement by local populations in the creation, content and conduct of a program or policy designed to change their lives,” (Jennings 1). The idea of people participating in their own development hinges on one important assumption; that people are healthy enough to take part in that development. Four billion cases annually of diarrhea serve to undermine this assumption and underscore the importance of improving water access. As long as half of the world’s hospital beds are filled by patients sick with water-borne diseases, the pace of development will be slowed (Water for Life Decade). One major benefit of improving access to water is ensuring that people are healthy enough to help themselves.

Another view of development, as put forth by Nobel laureate Amartya Sen, is that “Development can be seen... as a process of expanding the real freedoms that people enjoy,” (Sen 36). Sen continues to articulate development as a process which “requires the removal of major sources of unfreedom [or limits]: poverty as well as tyranny, poor economic opportunities as well as systematic social deprivation, neglect of public facilities as well as intolerance or overactivity of repressive states,” (Sen 3). Sen specifically names the unfreedom “to enjoy clean

water or sanitary facilities” (Sen 4). A case study in India found that the empirical evidence, “clearly indicates that bustee [informal settlement] households routinely experience [water related] illness as a barrier to securing their livelihoods (Kabir et. al. 721). This is a prime example of the unfreedom to enjoy clean water stopping people from enjoying the freedoms of their livelihoods.

In 2000, the world’s development objectives were explicitly outlined in the United Nation’s Millennium Development Goals (MDG). The vital role that water plays in development was recognized in the 7th MDG, Environmental Sustainability. The third target of this goal is to, “halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.” The relationship between water and informal settlements was also recognized, as the following target of this goal is, “by 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers,” (The Millennium Development Goals Report 45). Many academics have grasped the gravity of this relationship, writing that to meet the MDGs, “there is a dire need for reconsideration of the slum areas in the developing world as far as water supply is concerned,” (Murage and Ngindu 837).

Finally, safe water is so important that it has been recognized as an inalienable human right in multiple international charters. As early as 1948, the Universal Declaration of Human Rights implied that water was a human right in Article 25 which reads, “Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing...,” (Universal Declaration of Human Rights). Of course, in order to meet the demands of this article, a sufficient amount of safe water is needed (Gleick 492). Nearly 30 years later, water remained at the top of the agendas of international bodies. The concluding statement of the 1977 Mar del Plata conference explicitly states that, “all peoples,

whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs,” (Report of the United Nations Water Conference). A decade later, the 1989 Convention of the Rights of the Child put forth, in no uncertain terms, that states must take measures to “combat disease and malnutrition... through, inter alia, ... the provision of adequate nutritious foods and clean drinking water,” (U.N. Convention on the Rights of the Child). Finally, less than a decade ago, “access to water was considered a human right by the UN Economic and Social Council in 2002,” (Dagdeviren and Robertson 12). The persistence of declarations of the right to water demonstrates the importance of this issue.

Impacts of the Lack of Safe Water

In order to understand the benefits of adequate access to clean water, it is most helpful to highlight the varied costs of water poverty. That is to say that the reduction of negative outcomes resulting from inadequate water constitutes the benefits of adequate water. By understanding the range of negative outcomes, it is possible to understand the plethora of benefits of an ample supply of water. The consequences of water poverty, and thus the benefits as well, affect three spheres of life. The first, and most obvious, is the impact of safe water scarcity on health. This then directly affects two other spheres of life; economic and social.

Safe and clean water, in this paper, is defined as water that people can use for any purpose without negative health impacts. The World Health Organization categorizes relevant contaminants of drinking water within three broad categories: Microbial (bacteria and viruses, such as cholera), chemical (such as lead), and contaminants affecting acceptability (such as turbidity) (Guidelines for Drinking Water 3-7). Drinking water that is contaminated with matter from any of these categories can have significant impacts on human health, and is therefore not

safe. Water poverty, in this paper, is the lack of a sufficient quantity of safe water to be hydrated and maintain hygienic conditions. Water poverty has immense effects on all spheres of the lives of individuals and communities.

People use water in many different ways such as drinking, washing their bodies, washing dishes and clothing, and irrigating crops. The many ways that people use water leads to the many ways that water can affect human health. Although drinking water is the most likely use of water to negatively impact human health, water can have devastating impacts on human health even when it is not used for drinking. Transmission can occur via water washed diseases, such as scabies, which are caused by poor personal hygiene. Incidence of these diseases could be reduced by providing adequate safe water. Water is also an important vector for many diseases. Malaria, for example, is spread by mosquitoes that breed in standing water. Responsible water management could reduce the incidence of these water related diseases (Mintz et. al. 1565). The most common health outcome of unsafe water is diarrheal diseases, which can lead to further health impacts of water poverty. An estimated 50% of all childhood malnutrition is associated with repeated bouts of diarrhea resulting from inadequate amounts of safe water (Prüss-Üstün et. al. 11). Multiple cases of diarrhea also serve to weaken the immune system, and opportunistic diseases indirectly kill millions of children every year (Trowbridge). There can be no question that access to safe water is crucial for survival.

The severe impacts of water on human health translate into dire economic consequences, the alleviation of which is rarely considered when looking at the benefits of adequate safe water. As the poor tend to have less access to safe water, the health, and thus economic burden of water poverty is disproportionately shouldered by the economically disadvantaged. One can understand the economic impacts of ill health by looking at the, “relationship between health and

income per capita,” as suggested by David E. Bloom and David Canning. In this model, the relationship is the result of four primary factors. First, healthier people tend to have more energy, and thus, be more productive. This can result in higher income. Second, the expectation of good health encourages the investment of education, as people expect to reap the benefits of such investments for a longer period of time. The more educated one is, the higher their income is likely to be. The third way that health can increase one’s income is through investment. Investment is made possible because people living longer are likely to save more for retirement. Savings are crucial for investments, and investments tend to increase income. Finally, increased health can decrease fertility rates, which can result in an increase in per capita income (Bloom and Canning 2). The relationship between health and income can be seen as causal in either direction. Health improvements can increase income, which can be used towards improving health, thus creating a “virtuous spiral” (Bloom and Caning 5). The spiral works the other way as well, and ill health can destroy economic progress, and create a poverty trap for the poor. In this way, “poor health is more than just a consequence of low income; it is also one of its fundamental causes,” (Bloom and Caning 5).

While this model captures several of the economic consequences for general ill health, water has several specific economic consequences. One major impact of poor water infrastructure is the opportunity cost, “of time and effort by persons carrying water from distant and often polluted sources,” (Mintz et. al. 1565). UNICEF puts the number at 40 billion work hours lost carrying water every year in Africa alone. The annual economic costs resulting from lost production and medical treatment of water borne illness in India was calculated to be \$600 million (Trowbridge). Aside from the actual expenditures, the way in which the costs of water related illness affect families is significant. While some of the expenses of the poor can be

planned for, “illness may strike as a shock, that is, it may be an unexpected event that leads to economic and social crisis”. Shocks can have one of two economic outcomes, one prior to the shock, one after. If the family expects shocks such as illnesses, they will take steps to hedge against these risks. These risk-mitigation methods tend to reduce income relative to pure income maximization where the risk is not present. One example would be to be self employed in the informal sector. In this way, an individual can protect themselves against getting fired if they get sick. However, this employment may result in a substantially lower income. The other outcome, if a family is unprepared for a shock such as illness, can be the liquidation of important and even productive assets, such as livestock or gold.

The third effect of water poverty is the social impact that it has. By far, the most salient social impact relating to inadequate access to safe water is the burden on women. This manifests in a multitude of ways. One of the primary consequences of a lack of accessible water is that women and girls are most often responsible for fetching water, which can be several kilometers away from the home (Trowbridge). According to the UN, women and girls collect 71% of the world’s water. Even at a young age, the consequences are more severe for girls, as girls collect more water than boys (The Millennium Development Goals Report 44). The time girls spend fetching water can make attending school impossible, increasing the gender gap (Water, Sanitation, and Education). Fetching water is not the only way that women and girls are uniquely hurt by a lack of safe water. Women are likely to wait longer than men before seeking treatment for medical issues. This can often be the result of cultural norms that dictate that women put their needs behind the needs of their families (Kabir et. al 714). Beyond physical health, a woman’s mental health can be put at risk if she falls sick. If a woman is unable to do what her husband expects of her, “women may find themselves abandoned by their husbands or

forced to accept co-wives,” (Kabir et. al. 8). Despite women bearing the burden of most of the problems resulting from a lack of water, and related sickness, there are some social impacts to entire families. Social networks, an important part of life in many developing countries, may become weaker in the face of illness. This can happen as a result of an inability to meet the expressed or implied commitments of those networks, or if the illness is chronic, the household may “become a net drain on the other members of the network (Kabir et. al. 8).

These health, economic, and social consequences affect all people experiencing water poverty whether in a rural or urban setting. While informal settlements also suffer from these consequences, in many cases more acutely than other communities, there are a range of additional consequences that result from the unique context of informal settlements. In order to understand the role of inadequate quantities of safe water in informal settlements, it is first important to gain a firm understanding of what an informal settlement is.

Informal settlements have sparked an immense amount of debate in academic and policy discussions. The first point of contention tends to be what to call these living arrangements. The names used range from slum to squatter settlement to shantytown, each with their own connotations. The name slum seems to suggest social disorder, violence, and crimes. The term “slum” can be seen as an outsider’s perspective, and suggests a certain level of homogeneity of the experiences of people in slums (Obrist et. al. 321). The term “shanty-town” has also faced criticism because it defines an area by the low quality of houses. In so doing, “it obscures the possibilities seized by many individuals for improving their houses,” (Lloyd 116). Squatter settlement is not much better, as it highlights the illegal aspect of these settlements, although that may not be the most important part (Lloyd 116). Throughout this paper, the author has chosen the term “informal settlement” because this term serves to delineate a certain type of living

situation without any type of value statement attached. Further, while the author was working with the residents of such settlements on the outskirts of Nairobi, this is how they referred to their living style. Similarly, instead of “slum-dwellers”, this paper will refer to those living in informal settlements as the community of the informal settlements.

Informal settlements, almost by definition, are not officially recognized by the government. People working in these settlements do not hold title deeds, nor does most of the population have birth certificates or national identification cards. By nearly every metric, these people do not, officially, exist. As such records of these populations are scarce. That being said, there are several incontrovertible trends that can be observed. These settlements constitute the housing for a large portion of the world’s population. By some counts, one out of every six people in the world live in urban informal settlements (Sclar and Northridge 1381). Viewed another way, 62% of urban households in sub-Saharan Africa live in informal settlements. The specific numbers are less significant than the proof the statistics provide that informal settlements are home to a very significant portion of the world’s population (The Millennium Development Goals Report 45). It is clear that people are continuing to migrate to informal settlements at increasing speeds (Field and Kremer 3). What is also clear is that the problem of safe water shortages in these informal settlements is not going away, but getting worse as demand for water services strains insufficient supply (Dagdeviren and Robertson 2). It is also incredibly clear that the large scale, neo-liberal reforms of the previous several decades have not helped alleviate water poverty in a substantial or sustainable way, as per capita water consumption was shown to be lower in 1997 than 1967. The 1980’s and 1990’s have even been called “the lost decades” for achieving improved access to water (Dagdeviren and Robertson 7).

Informal settlements are significant, growing, and need to benefit from a new approach to improving water.

Informal settlements represent some of the most troubling problems facing developing countries today. One author suggested that these settlements are, “the spatial manifestations of urban poverty, social exclusion, and inappropriate government policies, ”(Sclar and Northridge 1381). While informal settlements span the globe, and the communities living in them have substantially different livelihoods and struggles, there are several aspects of these settlements that are common to nearly all of them. First of all, informal settlements tend to exist on the least desirable pieces of land. This is the land that has the lowest market value, and is thus the most affordable. These settlements are often located on mountainsides, uncultivable soil, and floodplains (Solo et. al. 15).

Another common trait to informal settlements around the world is their illegal status. This is most clearly seen through the lack of land tenure granted to the residents (Dagdeviren and Robertson 9). One approach to the reasoning behind government’s reluctance to recognize informal settlements is that most governments recognize only a certain standard of community; often this definition includes basic urban services. Because only recognized, and thus fully serviced neighborhoods, are permitted under law, “any community that lacks services must be illegal,” (Solo et. al. 13). The result is that the settlement, the people in it, and any efforts to improve it are all ‘extra legal’. The lack of land tenure severely reduces incentives for investment, meaning real progress can be hard to achieve (Field 2).

The illegality of informal settlements results in an array of problems, many of which contribute to the severe water crisis in these areas. Residents of informal settlements do not receive government services such as water, drainage, sewerage, and rubbish collection. This

results in “poor environmental conditions that predispose their inhabitants to poor health outcomes,” (Murage and Ngindu 831). Beyond the lack of vital services, the communities of informal settlements are often denied rights afforded residents living in formal housing. Residents of informal settlements almost never have official addresses, and so commonly do not receive the right to vote, public education, or healthcare (Sclar and Northridge 1381).

Several other problems plague the communities of informal settlements. The structures in these areas are “made of flimsy materials are prone to ignite, frequently collapse, and offer scant protection against their residents vulnerable to injury violence, illness, and death,” (Sclar and Northridge 1381). The location of the settlements, on the outskirts of cities, means that the residents must pay for transportation to access employment or services provided in the city (Solo et. al. 13). Finally, government officials too often see informal settlements as nothing more than “‘problems,’ focusing variously upon their poor housing, sickness and malnutrition, crime, and social disorganization” (Lloyd 118). As a result of this bias, as well as the sheer number and needs of the community of these settlements, they are ignored by official planning authorities (Solo et. al. 13).

Despite the hardships faced by the people living in informal settlements, there are positive aspects of these areas as well. In one way, these areas “represent an active, grassroots attempt by the desperately poor to take care of themselves,” (Sclar and Northridge 1381). In contrast to slums in the United States, informal settlements are not in a process of decay, but rather, a process of improvement (Solo et. al 28). Over time, informal settlements do generally see ad hoc regularization over a long period of time, often including connection to a formal water and sanitation network (Dagdeviren and Robertson 8). Until that happens, the lack of safe water remains an urgent problem.

These complex issues and factors have been combined into the official UN Human Settlements Programme definition of a slum. The agency responsible for living conditions around the globe has defined a slum household as lacking one or more of the following criteria:

1. Durable housing of a permanent nature that protects against extreme climate conditions.
2. Sufficient living space which means not more than three people sharing the same room.
3. Easy access to safe water in sufficient amounts at an affordable price.
4. Access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people.
5. Security of tenure that prevents forced evictions.

(Slums: Some Definitions)

With this in depth understanding of informal settlements, it becomes possible to understand the unique delivery (or lack thereof) and impacts of water in these areas. For multiple reasons, some of which have been mentioned, and some of which will be described in depth below, informal settlements do not have access to piped water, as do residents of formal settlements. As such, there are several ways these communities access water. In one study, nearly half of the survey sample had clandestine connections to a nearby water main (Galiani et. al. 3). Others buy water from residents of formal housing that resell water from the municipal network (Obrist et. al. 327). Finally, some use shallow, or hand dug, wells for water (Murage and Ngindu 834). In some informal settlements, there may be kiosks selling water from the municipal network. This water, however, can cost as much as five times the price that formal urban residents pay (Murage and Ngindu 834). In all of these cases, there is no guarantee for the water

quality, and residents of informal settlements often pay more for lower quality water than their formal counterparts.

As a result of these avenues of accessing water, several issues arise. The first, and perhaps most prominent, are the joint issues of transportation and storage. Common among the various ways to collect water, including irregular water supply through clandestine connections, as well as kiosks and water sellers, is that the water often has to be transported from point of purchase to the home. Additionally, common to all techniques, there is an economy of scale resulting in an advantage in collecting more water than an individual or family can use at that very moment. This means that water has to be stored for later use (Deb et. al. 131). The quality of water deteriorates rapidly in containers, “due to the circumstances surrounding haulage, storage and handling of such water from the water supply point until used by consumer,” (Jagals and Williams 378) . En route between the water point and the home, environmental pollutants such as dust could contaminate the water. Once delivered to the house, open containers are generally left with no cover, leaving the container open to contamination. One observer found flies at the waterline of most containers viewed (Jagals and Williams 378). Water is often scooped out of the container with a cup kept nearby. This cup is exposed to contaminants such as flies, dust, and unwashed hands (Jagals and Williams 378). Various factors, such as the material of the container, can affect the risk of contamination. The porous surface of clay containers, for example, may support the growth of bacteria (Trevett et. al. 264).

The other common supply of water in informal settlements is shallow or hand dug wells. While this ground water is often safely used for rural water access, the space and economic constraints of informal settlements make this a potentially deadly option. The issue arises when considering the other end of the human water cycle, that is, waste water. Pit latrines are the most

often used toilet structures in informal settlements. The distance between the latrines and the wells is recommended to be 15 meters (Murage and Ngindu 834). One study found that, due to the unique space constraints of informal settlements, the distance between the two was less than 15 meters in almost 40% of cases (Murage and Ngindu 834). Interestingly, residents seemed to be unaware of the role that the proximity of the two can play in allowing “micro-organisms to migrate from fecal contents into the underground water sources,” (Murage and Ngindu 835).

Another problem inherent in water in informal settlements is that clandestine connections can lower the water pressure. As such, when pipes crack, they are prone to contamination from any pollutants, such as open sewage, a common sight in informal settlements (Jagals and Williams 373).

The unique water quality problems of informal settlements, paired with the common consequences of water poverty create a special range of impacts, unique to, or exacerbated by, these settlements. Once again, the most direct impact is the way in which inadequate safe water affects health. The poorest households bear the majority of the burden of the risk of water borne diseases because these households are the least likely to be able to afford better means of storage, or any types of purification, as will be discussed below (Dasgupta 85). Additionally, the risks of fecal contamination of groundwater as described are exacerbated by the soluble nature of waste during the rainy season. As informal settlements lack adequate sanitation structures, this has profound negative impacts on health in informal settlements (Dasgupta 85). The day to day survival of the economic poor makes them uniquely vulnerable to economic shocks, such as lost wages due to absence from work. Fear of loss of income creates a strong incentive to return to work as soon as possible, even if an individual is not yet healthy. By returning to work before they are healthy, they are more likely to get sick again. This creates a cycle in which,

“employment insecurity forces these workers into a cycle of repeated illness, poor nutritional status and low work productivity resulting in the continuous degradation of their human and material capital,” (Kabir et. al. 713). Finally, the general living situation of those in informal settlements exacerbates all health problems. In addition to a lack of safe water, “poor sanitation, cramped housing, absence of waste removal, and inadequate ventilation are reflected in high levels of diarrheal and respiratory infection,” (Kabir et. al. 721).

The high level of disease risk is made significantly worse by the critical lack of health care in informal settlements. While the community of informal settlements works hard to better their living situation, health care can simply not be provided or created by the community itself. Health care requires trained personnel, physical examinations, diagnostic services, hospitalization, medication, follow-up care, prevention, and surveillance. The combination of these elements is nearly impossible to achieve in an informal settlement (Lee et. al. 2). That is not to say that there are no health options at all in these areas. Volunteer groups and NGOs offer medical services in informal settlements. Traditional medicine is also used in many informal settlements (Kabir et. al. 714). The most common source of medical treatment in informal settlements is private clinics and pharmacies, often run by unlicensed or poorly trained professionals (Lee et. al. 3). These private practitioners require fees for services, which the residents of informal settlements must pay out of pocket (Thaver et. al. 1441). Because the clinics are privately run and profit seeking, it is most beneficial to operate in areas of high population density. This explains why private practices tend to be found in informal settlements (Thaver et. al. 1442). An obvious problem with this type of health care is that it is only available to those who can afford to use the services. Moving beyond that, the next issue is the quality of medical care. One study in Pakistan found that 75% of practitioners in informal settlements

reached the correct diagnosis based on symptoms, but far fewer prescribed the correct treatment (Thaver et. al. 1445). The major problem observed with the prescriptions was over-medication of patients. Some private practitioners reported that patients “want more medicine as they want to get well soon” and in response, “practitioners agreed that ‘half of our medicines are tonics and antacids’ which according to them act as placebos,” (Thaver et. al. 1446). In informal settlements, private practitioners are competing with each other, as well as unqualified providers, to retain patients. They do this by offering the treatments perceived as best by the patient, rather than the most medically sound treatment (6 Thaver et. al. 1447). Aside from non-standard prescriptions, private practitioners often fail to execute other important health actions, such as give the patient explanations or behavior modification advice (Thaver et. al. 1446). The failures of the informal health care system, and increases in illness, have significant economic impacts.

The economic impacts of decreased health resulting from a lack of safe water fall into three categories: increased expenditure, decreased income, and increased employment insecurity. Increased expenditure is partially a result of high spending on healthcare, which is the third largest expenditure of most households in informal settlements, behind food and rent (Kabir et. al 713). The other major expenditure related to water poverty is the cost of water. As described above, water can cost residents of informal settlements many times the amount that people living in formal areas pay. Also, transportation costs of water, either in expenditure or opportunity cost of time spent, must be considered.

The other major impacts are decreased income and increased employment insecurity. These two tend to overlap, as staying home from work sick can have both of these effects. The majority of the community of informal settlements who earn wages are paid on a daily basis, and as such, receive no sick pay. The obvious outcome is that, “when a worker becomes ill and is

unable to work, he immediately loses income,” (Kabir et. al 711). Job security is also at risk if a working family member falls ill. Residents of informal settlements tend to work as unskilled laborers, and are therefore easily replaceable (Kabir et. al 712). Income generating adults are not just impacted by their own health, because an ill child may require that an income earning adult not attend work in order to provide care (Kabir et. al 717). The economic impact can seem like a trap when one considers that, “unlike some other types of shock, illness necessarily directly affects the human resources of a household and acts to limit certain options of response,” (Kabir et. al 720). Finally, the scope of the economic predictions may be grossly understating the economic risks of ill health in informal settlements. The risk of a large scale epidemic of communicable diseases due to a lack of healthcare informal settlements threatens to reverse the economic gains made by emerging economies such as Brazil, China, and India in much the same way that AIDS has done to Africa in the past 20 years (Lee et. al 4).

The above evidence conclusively demonstrates that the global lack of water and sanitation is a crisis in need of urgent intervention. The wide ranges of consequences of inadequate safe water make the benefits of provision of safe water clear. Removing these consequences would improve people’s health, economic standing, and social status, especially the status women. It is important to note that improving each of these facets of life has wide ranging implications. As one example, providing clean safe water can allow girls to attend school, which allows them to participate in the workforce, bettering the lives of the women, their families, and their countries as a whole. The ripple effects of improving water and sanitation can not be overstated. Just as each of the consequences of a lack of safe water is more severe in informal settlements, so too do the benefits have the potential to have larger impacts. The next

section of this paper will look at the range of options for providing adequate safe water to the communities of informal settlements.

Obtaining the Benefits of Safe Water

Interventions for the provision of water can be separated as hardware or software (Varley et. al 619). Hardware interventions include physical interventions, such as infrastructure improvements, technology, and products. Hardware can be further categorized as either supplying water or reducing the risk of morbidity and mortality from water. Within the realm of risk reduction, interventions can be *ex ante* (preventative) or *ex post* (curative). These categories are not mutually exclusive, and interventions often work best when paired with interventions from other categories. In order to understand the range of options, interventions will be looked at in these categories.

Within the hardware category, one of the most important interventions to discuss is water infrastructure improvements. This is a critical point of discussion, because the nearly all of the water access problems in informal settlements are a result of a lack of this infrastructure. Meaningful improvements to water infrastructure in informal settlements could maximize the benefits described in this paper and alleviate water poverty. This is the most desirable intervention, and would make the others unnecessary. Piped water in Buenos Aires led to a decrease in diarrhea episodes of as much as 74% of the baseline rate. In addition to decreasing the incidence of diarrhea, piped water reduced the duration and severity of those incidences (Galiani et. al. 9). In addition to the economic savings as a result of decreased ill health, families with access to piped water reduced water related expenditures by up to 95%, the savings representing some 4.5% of the average total family income (Galiani et. al. 11). This income was found to be spent on food consumption, thus reinforcing the health benefits of access to safe

water. Even those previously using clandestine connections benefited from piped water. Water infrastructure improvements may be seen as the ultimate goal, while other interventions serve as temporary solutions to improve livelihoods and save lives until that goal is achieved.

The fact that water infrastructure isn't currently in place, despite the tremendous benefits it could provide, suggest that there must exist nearly insurmountable barriers to doing this. Indeed, this is the case. The barriers to improving infrastructure in informal settlements are tremendously high. Limits are imposed by costs, physical topography, and poor governance.

While the specific cost of infrastructure investments in informal settlements are difficult to calculate, evidence shows that the cost is very high. The costs can be hard to calculate because many different agencies and utility licensees must be involved in various ways. Even in formal settlements, little is known in relation to infrastructure costs (Abiko et. al. 2). That being said, there are several indicators that the costs of such investments would be tremendous. One study on the costs of infrastructure in informal settlements in Brazil found that two of the main factors contributing most significantly to the price are the size of the slum and the physical conditions of the slum. High population density was also seen to increase prices (Abiko et. al. 20). In order to mitigate these high costs, development agencies tend to use low standards for infrastructure. This results in rapid deterioration, and a need for constant maintenance (Dagdeviren and Robertson 9). This can raise the costs of infrastructure in the long run. Lastly, the costs of investment in infrastructure are increased by the multi-dimensional demands of these investments. This means that an investment in water infrastructure requires investments in sewerage, drainage, garbage collection, and roads. Each of these infrastructure networks are interconnected, and can not function without the others. More water creates a need for sewerage. Sewerage requires rainwater drains to prevent backing up. Rainwater drains require garbage collection to prevent

waste from clogging the drains. Garbage collection requires roads, so that refuse can be gathered. In this way, it is not possible to lower costs by funding infrastructure in a piecemeal manner (Abiko et. al. 3).

The very land upon which informal settlements tend to be built, and its topography, provides immense problems. The location of these settlements, typically on the periphery of cities or in previously uninhabited land including flood plains, hills, ravines and desert land, “makes the extension of standard network utilities technically difficult (Dagdeviren and Robertson 11). These physical conditions common to informal settlements can increase costs and limit infrastructure investment. The first physical problem of informal settlements which limits the viability of infrastructure is the lack of roads. Roads are a crucial part of infrastructure, both in the primary function they serve, as well as providing channels for other infrastructure. In formal housing areas water pipes, electricity cables, and infrastructure needed for other services is often buried under a central roadway with residential connections branching off (Dagdeviren and Robertson 11). Because residents of informal settlements lack a technical understanding of urban planning, these areas are often developed haphazardly, without space being provided to install infrastructure lines (Solo et. al. 15). Laying pipes in such conditions would demand the creation of roads, and the resulting removal and relocation of houses. This has significant costs, both financial and social. Whereas water utilities in planned areas may be arranged by construction under a central roadway with residential connections branching off this, such a conventional approach is impractical in crowded informal settlements that have a random and haphazard development pattern (Solo et. al. 15).

Aside from the lack of roads, the capacity of local engineers and public works companies limits the opportunities to provide piped water to the residents of informal settlements. Local

engineers are likely to prefer service delivery systems that they are familiar with. Even the most modern systems “may turn out to be inappropriate for the difficult topography, soils, and other conditions of informal neighborhoods....” The lack of faith in or awareness of, alternative systems often results in higher costs or a lack of services for the poor living on difficult terrain (Solo et. al. 16). Public works companies, especially in poorer areas, are capable of running a water network, but not installing a new one. This becomes especially apparent informal settlements because creating a new water network requires high levels of public relations, social working, and on-site engineering (Solo et. al. 25).

Ineffective governance also has the impact of prohibiting water infrastructure investment. One of the main reasons that governments fail to meet the needs of the communities of informal settlements is corruption. Specifically, corrupt and inefficient water and public works companies represent a major hurdle in efficiently providing services to informal settlements (Solo et. al. 11). Interestingly, the privatization of water in Buenos Aires resulted in significantly increased investment, efficiency, productivity, and an expansion of services (Galiani et. al. 2). The government’s refusal to grant land tenure has also contributed to the absence of piped water infrastructure. The obligation of water companies to provide water is dependent upon residents having secure tenure of their property. This mandate is typically enumerated in legislation concerning public utilities or the contracts of private utilities (Dagdeviren and Robertson 10). Aside from providing water, if the government were to support, even tacitly, the development of infrastructure in the informal settlements, “their permanence may be seen as providing a stamp of approval or some degree of legitimacy to the residents,” (Dagdeviren and Robertson 10). In these ways, the government plays a role in ensuring that those living in informal settlements do not receive the benefits of piped water.

These broad ranges of substantial limitations explain why informal communities do not have access to water infrastructure, despite the important benefits it would provide. With thousands dying daily from a lack of clean water, simply waiting for the seismic changes that would be needed to bring piped water to informal settlements would prove devastating. Instead, stop gap measures must be put in place. The remainder of this paper will look at such measures.

Aside from piped water, there are several other ways to get water. One option is digging a well. Wells, however, tend to be of limited use in informal settlements. Boreholes are far too costly for private investment, and as described above, governments are unlikely to support this type of effort. Hand dug wells, due to the high population density and common use of pit latrines, are very likely to yield water that is bacteriologically contaminated.

The remaining source of water is rainwater harvesting. Rainwater harvesting typically uses a roof to collect rain, and a system of gutters to funnel the water into a storage container. The impacts and benefits of roof top water harvesting are, by nature, affected by rainfall. The amount of rainfall can vary dramatically from year to year, thus making this an inconsistent option for water supply (Kumar 46). Despite weather fluctuations, rooftop water harvesting, “could allow households to reduce their dependence from the water supply system,” although the impact would vary. The other variable that affects the impact of rainwater harvesting is the roof. The per capita roof area and the material that the roof is made of both impact the amount of water collected (Kumar 46). Galvanized iron, for example, has a higher coefficient of runoff than concrete (Kumar 47). The extent to which this may be a tool for alleviating water poverty would depend on the specific circumstances of a given informal settlement. Of note, informal settlements tend to have large family sizes, and often live in extremely small quarters. The result is a very small per capita roof area, limiting the benefit of rainwater harvesting.

Once water is obtained, whether from a kiosk, clandestine connection, wells or rainwater harvesting, it is vital to ensure that the water is safe, or of a quality suitable for use. The next category of hardware interventions provides ways to improve the quality of water, decreasing the consumer's risk of illness.

Perhaps the simplest option to purify water is to boil it. This will inactivate most biological contamination, such as viruses and bacteria. While this option is very simple, it has several drawbacks. First of all, the fire needed to boil the water could pose a risk to infants in the vicinity (Mintz et. al. 1567). A greater risk is posed by the flammable nature of structures in informal settlements and their proximity to one another. There are also important financial considerations, as the purchase of fuel (often charcoal) must be considered. The mass consumption of such fuels has a negative environmental impact as well. The health impacts of boiling water for storage are limited. Boiling provides no residual protection, and water can be recontaminated easily after cooling (Mintz et. al. 1568). Also, boiling does not remove chemical contaminants.

Another intervention for ensuring high quality water is storage containers that prevent contamination by having a tightly sealing lid and providing a narrow mouth so that no contaminants can come in contact with the water at any point. Case studies show that specialized containers can be very effective, reducing the spread of cholera by nearly 75% (Deb et. al. 131). In at least one study, a specialized storage container was found to be more effective even than chlorination (Deb et. al. 130). Containers designed to decrease the risk of contamination face cost constraints, in that if they are too expensive for the poor to buy, they will not have any impact. Further, containers introduced for the use of water storage must meet traditional cultural

standards (Mintz et. al. 1569). High quality sourcewater is a prerequisite for using this intervention.

One of the most innovative water interventions is solar disinfection. In this process, a PET plastic bottle is filled with water to be purified and placed on the roof for several days. The pathogens in the water are inactivated by the ultraviolet radiation emitted by the sun. The effects of increased temperature resulting from leaving water in the sun help to make the process more effective (Mintz et. al. 1568). This is one of the cheapest options to purify water, but it has several drawbacks. First of all, certain meteorological conditions are required, as a lack of sun can limit the efficacy of this procedure. Additionally, turbidity decreases the level of penetration of ultraviolet radiation, decreasing the impact of disinfection. Similar to boiling, solar disinfection lacks any residual protection, and the opportunity exists for recontamination (Mintz et. al. 1568).

The final intervention commonly used for improving water quality is chlorine. Chlorine has been proven to be extremely effective at decreasing the incidence of water borne diseases (Deb et. al. 131). Chlorine can be sold to consumers relatively inexpensively, making it a viable option for informal settlements. One major advantage to the use of chlorine is the residual protection that it offers. This prevents recontamination of the water, making this intervention beneficial over a long period of time. The disadvantages of chlorine include the taste and odor of the water, which may discourage the use of chlorine (Mintz et. al. 1568). Also, there is a risk of the development of chlorine resistant microbes (Morris 310).

While hardware has many benefits, software interventions, such as hygiene interventions, have proven to be incredibly valuable as well. Software interventions often refer to education, social marketing, and/or training. Hand washing training is one of the most common software

interventions. This is a vital aspect of providing adequate safe water. Studies indicate that “hand–water contact is a principal cause of the recontamination of drinking water” (Trevett et. al. 263). Unclean hands will likely add more contaminants to water than clean hands. The need for training on hand washing is clear. In one study in an informal settlement, only 36% of respondents were found to wash their hands with soap after defecation (Trevett et. al. 263). None of the respondents of the study mentioned washing hands before any drinking water practice (Trevett et. al. 264). In a different study, fecal contamination was found on the hands of 44% of women tested during normal household activities (Trevett et. al. 267).

Hand washing interventions have been found to be incredibly effective. Simply washing hands with soap can reduce diarrheal diseases by 42% to 47% (Trowbridge). With such significant reductions in incidence of diseases, hygiene interventions, “seem to be at least as effective as the other interventions,” (Fewtrell et. al. 47). In addition to the benefits hygiene interventions can have on their own, software interventions have an important role to play in ensuring uptake and sustainability of various hardware interventions (Sobsey et. al. 227).

In the immortal words of Ben Franklin, “an ounce of prevention is worth a pound of cure”. These words certainly apply to the provision of safe water, as prevention of disease is a much better option, for many reasons, than treatment. No water network is entirely safe, as disease outbreaks in the United States have demonstrated (Morris 196). When diarrheal disease does strike, it is vital to have an effective treatment. Oral rehydration therapy is that treatment. Notably, many organizations have used ORT as a primary control mechanism, rather than investing directly in water interventions (Varley et. al 617). While it does save lives, this *ex poste* intervention does not help to address the many consequences of a lack of safe water. For example, adults will still have to miss work to care for children. The emphasis on ORT has

started to diminish as studies continue to confirm that other water sector interventions are comparable to ORT from a cost-benefit standpoint.

In addition to these specific and direct interventions, there are several options to alleviate the consequences of water poverty that do not relate directly to water. There exist several indirect long term strategies and factors that affect water poverty. Good education has been shown to increase water related health (Trevett et. al. 263). Household size was also found to be correlated to the risk of diarrheal disease in children aged 3-35 months (Trevett et. al. 268). Improving housing has also been shown to decrease disease risk (Trevett et. al. 268). These correlative factors will take time to affect, but provide goals for governments and the communities of informal settlements to aim for.

Of these range of interventions, from water supply to water treatment to education, there is often pressure to pick “the best” options for reducing the ill affects of water poverty in informal settlements. This is an impossible task. Each intervention works best for certain contexts. Factors that affect the appropriateness of an intervention include rainfall, sunny days, traditional practices, and economic status, to name a few. These factors vary widely across, and even within, informal settlements. Also, hardware, software, and treatment all have vastly different costs and benefits. One way in which several authors have tried to find the best option is through either cost effectiveness analysis or cost benefit analysis. These strategies are flawed an inappropriate for determining the usefulness of water related interventions because they fail to capture the true benefits. As Varley et. al. pointed out, “special difficulties are inherent in applying cost-effectiveness analysis to interventions having multiple benefits, and water supply and sanitation present these difficulties in an extreme form,” (Varley et. al 619). In fact, the first

step is to determine what type of analysis to carry out. CEA measures the costs of reaching some non-monetary outcome, such as a case of a disease prevented. This measure is necessarily limited in scope, as both interventions being compared must reach a common outcome. This measure will then exclude any benefits beyond that common outcome. This is inappropriate because, as discussed above, the benefits of alleviating water poverty are numerous and reach into many spheres. The multitude of benefits can not be measured in a CEA. The other measure, CBA, looks at the “benefits and costs of an investment are expressed in monetary units, adjusted for “economic distortions,” and discounted by the opportunity cost of capital,” (Varley et. al 620). This method inevitably fails to accurately capture the non-monetary benefits of water interventions. The economic value of a girl attending school can hardly be calculated, especially when considering the trans-generational impacts.

The WHO guidelines suggest that, “all interventions should be evaluated with the assumption that interventions are fully in use throughout a period of 10 years,” (Haller et. al. 469). This analysis biases estimates of impact against software interventions because it fails to capture the role of trans-generational diffusion of knowledge. The WHO guidelines ignore the multiplier effect. Take, for example, a mother who learns the importance of hand washing. She will teach her children, who will teach their children, and so on. All of this impact for the cost of one intervention. Finally, there are inherent risks in trying to determine the direct impact of an intervention. A control group is generally picked to be similar in makeup to the group using an intervention. While these groups are meant to be identical, the reality is that they are usually heterogeneous. Programs can be placed in a specific area, individuals can be screened for participation, and the decision to participate is usually voluntary. As a result of these factors, “those who were not exposed to a program are often not a good comparison group for those who

were, and any differences between the groups can be attributed to two factors: pre-existing differences (the so-called ‘selection bias’) and the impact of the program,” (Field and Kremer 4).

Recommendations

The first recommendation would be to change the framework in which informal settlements are viewed. Traditionally, informal settlements are defined by their differences. Informal settlements are differentiated by their different legal status, their unique burdens, and their “out of the way” locations. In order for meaningful progress to be made, informal settlements must be recognized; the focus must be shifted towards interconnectedness, and away from differentiation. Informal settlements, while often out of site, can not easily be put out of mind. It is important to recognize that, “people, commodities, knowledge as well as less attractive materials and agents, such as wastewater, chemical pollutants or biological pathogens in water, food, air or soil, move across residential boundaries,” (Obrist et. al. 321). As the authors write,

The three closely interrelated issues of fluid and solid waste removal, water provision and health care call for a broader and more integrated perspective. Waste produced in one area may cause pollution in another area, and the provision of services to a large number of households necessitates concerted action. Not just the material flow but more importantly the management of wastewater connects various settlements (horizontal connections) as well as individuals, social groups and institutions (vertical connections). Networks of sewage channels and water pipes are concrete manifestations of connections between service providers and households. Policies, regulations and contracts are less visible but also create connections between government bodies, private companies and customers.
(Obrist et. al. 333)

The results of this paradigm shift will have far reaching impacts. One impact, invariably, will be increased funding from both national governments and foreign donors. By understanding the interconnectedness of informal settlements to the world at large and their unique health risks, investments are likely to increase. No longer will altruism be the motivation for investment, but

rather, investing in water will be seen, “as an investment in self-protection, given that microbes know no borders,” (Garrett 1). This increased funding is crucial because many good options lack only that key element. Interventions that are good and effective do exist; they just lack funds to expand to meet the needs of the sixth of humanity that lack water.

This increased investment, both from the governments of less developed countries and donor countries must be invested following certain guidelines to maximize effectiveness. Donor countries, for their part, often fail to realize that, “it will take at least a full generation (if not two or three) to substantially improve public health,” (Garrett 1). Donors need to accept this, and invest in long term programs that may not have results for a long period of time. Additionally, donors need to allow the people on the ground to determine priorities in funding. Currently, most donor funds are restricted according to the donor’s interests, values, and politics (Garrett 5). Unrestricting funds could allow them to be used where they are most needed. Finally, donors need to coordinate better. Improving global health will take the contributions of many donors, and those donors must work together to be effective, (Garrett 6).

Of course, the less developed countries have an important role to play as well. Both directly and indirectly, the government can play a role in solving the water crisis. Mexico proved the role the government can play in mitigating the negative effects of water poverty when in 1991 legislation was enacted banning the use of sewage for irrigation. The policy had a 50% decrease in diarrheal diseases, proving that governments have the opportunity to help reduce the impacts of the water crisis.

Governments must pass pro-poor policies that support the alleviation of water poverty. One way in which this could be done would be to change the way areas are planned. Currently, most LDCs use the “zoning” method, which was introduced by developed countries. This

approach is inappropriate in many cases, as it mandates what can not be built in an area, which hurts development (Solo et. al. 28). Some suggest that a better approach might be similar to the US Homesteading Act, which encouraged people to develop vacant land. The governments of LDCs must also work to improve their health care systems, including improving the experience of being a doctor. The pull of developed countries for doctors as their populations age will decrease the general health of the less developed countries, making worse already problematic health conditions (Garrett 2).

From this discussion, several conclusions emerge. First of all, water is important for its role as a role as a driver of development and its status as a human right. The benefits of water are further reaching than most literature recognizes. The consequences of water poverty in the health, economic, and social spheres, and the associated ripple effects, are tremendous, but can not be easily measured. The removal of these consequences, or benefits, which would come with adequate access to safe water also cross boundaries into many spheres of the human experience. Just as the impacts of safe water shortages are more severe in informal settlements as a result of their unique context, so too can tremendous benefits be realized in these area. While piped water would be the ideal solution, the large portion of the world's population living in informal settlements does not have time to wait for this infrastructure. Instead, life saving interventions must be put in place. From the discussion of interventions, it is clear that several largely viable and inexpensive options, such as solar disinfection and especially chlorine, exist. Those interventions must be accompanied by software, such as education and social marketing, to maximize their impacts, and thus, their benefits. Governments, both developed and developing, have roles to play in obtaining the benefits of safe water. It will not be easy to eliminate water poverty in the rapidly growing informal settlements around the world, but it must be done. The

morbidity and mortality rates are too high, and the potential benefits are too large, for the world to miss this opportunity.

Works Cited

- Abiko, Alex, Luiz Cardoso, Ricardo Rinaldelli, and Heitor Haga. "Basic Costs of Slum Upgrading in Brazil." *Global Urban Development*. 3.1 (2007): 1-23. Print.
- Bloom, David, and David Canning. "The Health and Wealth of Nations." Department for International Development. 1999.
- Dagdeviren, Hulya, and Simon Robertson. "Access to Water in the Slums of the Developing World." *Working Paper*. 57. Brasilia, Brazil: International Policy Centre for Inclusive Growth, 2009. Print.
- Dasgupta, Purnamita. "Valuing Health Damages from Water Pollution in Urban Delhi, India: A Health Production Function Approach." *Environment and Development Economics*. 9. (2004): 83-106. Print.
- Deb, B.C., B.K. Sircar, P.G Sengupta, S.P De, and S.K Mondal. "Studies on Interventions to Prevent Eltor Cholera Transmission in Urban Slums." *Bulletin of the World Health Organization*. 64.1 (1986): 127-131. Print.
- Dinesh, Kumar. "Roof Water Harvesting for Domestic Water Security: Who Gains and Who Loses." *Water International*. 29.1 (2004): 43-53. Print.
- "Fact Sheet: Use of Water Worldwide." *Water Pressure*. Peace Corps, Web. 6 Dec 2009.
- "Factsheet on Water and Sanitation." *Water for Life Decade*. United Nations, Web. 6 Dec 2009.
- Fewtrell, Lorna, Rachel Kaufmann, David Kay, Wayne Enanoria, and Laurence Haller. "Water, Sanitation, and Hygiene Interventions to Reduce Diarrhea in Less Developed Countries: a Systematic Review and Meta-analysis." *Lancet Infectious Diseases*. 5. (2005): 42-52. Print.
- Field, Erica. "Property Rights and Investment in Urban Slums." *Journal of the European Economic*. Print.
- Field, Erica, and Michael Kremer. "Impact Evaluation for Slum Upgrading Interventions." *Doing Impact Evaluation Series*. (2006): Print.
- Galiani, Sebastian, Martin Gonzalez-Rozada, and Ernest Schargrodsky. "Water Expansions in Shantytowns: Health and Savings." *Economica*. (2008): 1-16. Print.
- Garrett, Laurie. "The Challenge of Global Health." *Foreign Affairs* 2 Jan 2007: 1-16. Print.
- Gleck, Peter. "The Human Right to Water." *Water Policy*. 1. (1998): 487-503. Print.

"Guidelines for Drinking Water." 3rd ed. 1. Geneva, Switzerland: 2008. Print.

Haller, Laurence, Guy Hutton, and Jamie Bartram. "Estimating the Costs and Health Benefits of Water and Sanitation Improvements at Global Level." *Journal of Water and Health*. 5.4 (2007): 467-480. Print.

Jagals, P., and E. Williams. "The Effects of Supplied Water on Human Health in an Urban Development with Limited Basic Subsistence Facilities." *Water South Africa*. 23.4 (1997): 373-378. Print.

Jennings, Ray. "Participatory Development as New Paradigm: The Transition of Development Professionalism." Oct 2000. USAID, Web. 6 Dec 2009.

Kabir, Azmal, Aatur Rahman, Sarah Salway, and Jane Pryer. "Sickness Among the Urban Poor: A Barrier to Livelihood Security." *Journal of International Development*. 12.5 (2000): 707-722. Print.

Lloyd, Peter. "Shantytowns in Developing Nations." *Current Anthropology*. 20.1 (1979): 114-117. Print.

Mintz, Eric, Bartram Jamie, and Lochery Peter. "Not Just a Drop in the Bucket: Expanding Access to Point-of-Use Water Treatment Systems." *American Journal of Public Health*. 91.10 (2001): 1565-1570. Print.

Morris, Robert. *The Blue Death*. London: HarperCollins, 2007.

Murage, Elizabeth, and Augustine Ngindu. "Quality of Water the Slum Dwellers Use: The Case of a Kenyan Slum." *Journal of Urban Health*. 84.6 (2007): 829-839. Print.

Obrist, Brigit, Gueladio Cisse, Kone Brama, Dongo Kouassi, and Stefanie Granado. "Interconnected Slums: water, Sanitation, and Health in Abidjan, Cote d'Ivoire." *European Journal of Development Research*. 18.2 (2006): 319-336. Print.

Report of the United Nations Water Conference. United Nations. Mar del Plata, 14-25 March 1977.

Riley, Lee, Albert Ko, Alon Unger, and Reis Mitermeyer. "Slum health: Diseases of neglected populations." *BMC International Health and Human Rights*. 7.2 (2007): 1-6. Print.

Sclar, Elliott, and Mary Northridge. "Slum, Slum Dwellers, and Health." *American Journal of Public Health*. 93.9 (2003): 1381. Print.

Sen, Amartya. *Development as Freedom*. Garden City: Anchor Books, 1999.

"Slums: Some Definitions." *Twenty First Session of the Governing Council*. UN-Habitat. Nairobi, Kenya: 2007. Print.

- Sobsey, M.D., T. Handzel, and L. Venczel. "Chlorination and Safe Storage of Household Drinking Water in Developing Countries to Reduce Water Borne Disease." *Water Science and Technology*. 47.3 (2003): 221-228. Print.
- Solo, Tova, Eduardo Perez, and Steven Joyce. "Constraints in Providing Water and Sanitation Services to the Urban Poor." *WASH Technical Report*. (1993): 1-42. Print.
- Thaver, Inayat, Trudy Harpham, Barbara Mckpake, and Paul Garner. "Private Practitioners in teh Slums of Karachi: What Quality of Care do they Offer." *Social Science Medicine*. 46.11 (1998): 1441-1449. Print.
- "The Challenge of Slums." *Global Report on Human Settlements* . Sterling: VA, 2003. Print.
- Prüss-Üstün, A, R. Bos, F. Gore, and J. Bartram. Safer Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health. World Health Organization, Geneva, 2008.
- "The Millennium Development Goals Report." 2008. New York, NY: United Nations, 2008. Print.
- Trevett, Andrew, Richard Carter, and Sean Tyrrel. "The Importance of Domestic Water Quality Management in the Context of Faecal-Oral Disease Transmission." *Journal of Water and Health*. 3.3 (2005): 259-270. Print.
- Trowbridge, Erin. "Child Survival Fact Sheet: Water and Sanitation." *Press Centre*. UNICEF, Web. 6 Dec 2009.
- U.N. Convention on the Rights of the Child. 1989. UN General Assembly Document A/RES/44/25
- Universal Declaration of Human Rights*, G.A. res. 217A (III), U.N. Doc A/810 at 71 (1948)
- Varley, R., J. Tarvid, and D. Chao. "A Reassessment of the Cost-effectiveness of Water and Sanitation Interventions in Programmes for Controlling Childhood Diarrhoea." *Bulletin of the World Health Organization*. 76.6 (1998): 617-631. Print.
- "Water, Sanitation, and Education." *Water, Sanitation, and Hygeine*. UNICEF, Web. 6 Dec 2009.